DMIC

JPRS: 27,980

TT: 64-51996

24 December 1964

SAFETY ENGINEERING IN WORKING WITH BERYLLIUM

ok

by I. Ya. Yukhim

61180

- USSR -

U. S. DEPARTMENT OF COMMERCE
CLEARINGHOUSE FOR FEDERAL
SCIENTIFIC AND TECHNICAL INFORMATION
JOINT PUBLICATIONS RESEARCH SERVICE
Building Tempo E
East Adams Drive, 4th and 6th Streets, S. W.
Washington, D. C. 20443

Price: $1.00

F O R E W O R D

This publication was prepared under contract for the Joint Publications Research Service as a translation or foreign-language research service to the various federal government departments.

The contents of this material in no way represent the policies, views or attitudes of the U. S. Government or of the parties to any distribution arrangement.

PROCUREMENT OF JPRS REPORTS

All JPRS reports may be ordered from the Clearinghouse for Federal Scientific and Technical Information. Reports published prior to 1 February 1963 can be provided, for the most part, only in photocopy (xerox). Those published after 1 February 1963 will be provided in printed form.

Details on special subscription arrangements for any JPRS report will be provided upon request.

All current JPRS reports are listed in the Monthly Catalog of U. S. Government Publications, available on subscription at $4.50 per year ($6.00 foreign), including an annual index, from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

All current JPRS scientific and technical reports are cataloged and subject-indexed in Technical Translations, published semimonthly by the Clearinghouse for Federal Scientific and Technical Information, and also available on subscription ($12.00 per year domestic, $16.00 foreign) from the Superintendent of Documents. Semiannual indexes to Technical Translations are available at additional cost.

JPRS: 27,980

SAFETY ENGINEERING IN WORKING WITH BERYLLIUM
- USSR -

[Following is a translation of an article by I. Ya. Yukhim, Moscow Institute of Steel and Alloys, in the Russian-language periodical Metallovedeniye i Termicheskaya Obrabotka Metallov (Physical Metallurgy and Heat Treatment of Metals), Moscow, No 11, Nov 1964, pp 39-41.]

The safety measures used when handling beryllium and its compounds, especially the soluble ones (fluorides, oxyfluorides, chlorides, sulfides, acetates, etc.), are determined by their toxicity. Although the soluble compounds of beryllium are more toxic to man, one must not underestimate the danger presented by beryllium and its insoluble compounds after penetrating into the respiratory organs in the form of finely dispersed aerosols. The maximum permissible concentration of beryllium and its compounds has been set in the USSR at 0.001 mg/m^3.

Acute poisoning results from brief exposure to heavy concentrations of beryllium (0.1 mg/m^3) or its compounds, with symptoms of beryllium casting fever - elevated temperature, severe coughing, dyspnea, pain, hoarseness, and lung inflammation. Chronic poisoning results from prolonged exposure to even comparatively low concentrations of beryllium and its compounds. They may injure the skin. They commonly cause ulcers on the forearms and wrists, eczema, etc.

Particularly significant is berylliosis - chronic pulmonary granulomatosis characterized by a loss of weight, weakness, anorexia, ready fatigability, dyspnea, and dry cough. Other typical symptoms of berylliosis include a decrease in the vital capacity of the lungs, cyanosis, thickening of the fingers, and increasing circulatory insufficiency.

Beryllium and its compounds may produce a strong allergic reaction. Some persons handling these substances become highly

sensitive to beryllium. Beryllium poisoning may take the form of lung inflammation.

The toxicity of beryllium and its compounds has been demonstrated by many investigators [1-3]. They found that in the development of berylliosis in connection with the production of beryllium alloys, the main role is played not by the dust of the alloy but by aerosols of beryllium oxide condensation or metallic beryllium fumes. Since in obtaining beryllium from ore soluble beryllium compounds are formed and their fumes pollute the air, the apparatus and equipment must be air-tight and the injurious substances removed by aspiration. Pneumatic transport should be used.

The equipment employed to heat and fuse beryllium and its alloys (furnaces, etc.) should be kept in special rooms with control panels on the outside. The rooms are furnished with local exhaust ventilation, peep holes, and light so that the process can be observed from the outside.

Since finely dispersed aerosols of beryllium condensation (less than one micron in diameter) may be released when melting and casting beryllium and its alloys, all the operations should be carried out in hermetically sealed vacuum furnaces to prevent pollution of the air by the aforementioned aerosols. The outlet for the air and gases from the vacuum pumps should be connected to an exhaust fan and cleaned before being released into the atmosphere.

Besides the usual safety measures applying to work with high-frequency vacuum furnaces, efforts are made to prevent water from the cooling system from penetrating into the working space of the furnace (through corrosion of the housing of the water jacket or induction coil) and to prevent water from coming into contact with the liquid metal, thereby preventing a possible explosion. Emergency signals are used in addition to systematic inspection of the cooling apparatus. For example, on the days when the furnace is in operation, they place on a special attachment a container with a substance that conducts an electric current only when it dissolves in water (crystals of table salt). When water reaches the bottom of the furnace, the salt dissolves and the emergency signal system is activated, warning those present to turn off the furnace and remove all the workers.

It is also essential to keep the heating elements of the furnace clean since they may make contact if dust gathers on the coils of these elements. The inner walls of the vacuum furnace must likewise be systematically cleaned (after several smelting operations). The furnace should be opened only after it has cooled completely. Otherwise, there could be an explosion due to instantaneous igniting of the scale. Finely dispersed aerosols of the condensation of molten

beryllium deposited on the walls of the furnace are quickly oxidized with an explosion. When cleaning the furnace, it is essential to prevent the instruments from striking or falling on the scale-covered walls lest there be spontaneous ignition. It is also important to keep in mind the danger of poisoning here because the smoke contains beryllium dioxide and other compounds.

First the fine particles on the walls of the furnace are cleaned off with a wire brush, after which the slag is removed with scrapers. A vacuum cleaner is normally used with the dust tank reinforced with FPP-15 cloth. The worker wears an LG-5 pneumatic suit.

The charge is prepared in the same place as the furnace. The beryllium is crushed and mixed in a glove box operating at a negative pressure of 20 mm of water column. Hermetically sealed mixing chambers operating at the above-mentioned pressure are used to treat powdered beryllium compounds.

The furnaces and apparatus capable of serving as sources of air pollution by finely dispersed beryllium aerosols are kept in enclosed compartments with air locks in which the air in the open door of the compartment does not move any slower than 1 m/sec. In treating less toxic compounds, use is made of equipment with housing in the working compartments of which air moves at the rate of 1-1.5 m/sec.

Of particular interest are the safety measures employed when making objects by the method of powder metallurgy [4]. Since finely dispersed materials are involved, the possibility of pollution of the air in the working spaces with the dust has to be reckoned with. Most of the dust results from pulverization of beryllium. Dry powdery substances must be handled in air-tight glove boxes. A negative pressure (chcked by a manometer) is maintained in the boxes to prevent the escape of dust.

Fine beryllium powder is obtained by grinding the metal on a lathe and pulverizing the shavings in an atmosphere of dry nitrogen in a disk grinder with water-cooled disks lined with beryllium. For safety sake all the equipment should be housed in boxes with openings for the hands and insertion of parts. The working parts of the presses are kept under hoods with Plexiglass front doors lined with insulating material and provided with a metal screen to prevent accidents and damage to the housing.

For lathes, milling and other metal-cutting machines it is best to set up individual suction pumps with air moving in the receiving heads at the rate of 10-15 m/sec. The equipment is automated and interlocked with the ventilation. When the machines are in operation, hoods with individual pumps should be

used along with the wet method of treatment or with emulsions.

In polishing objects made from beryllium or its alloys, use is made of polishing wheels shielded by deep casing with the tiniest of openings. Welding requires previous installation of movable connecting pipes to ventilation systems.

Hot pressing and sintering is safer than cold because of the widespread use of hermetic equipment. However, since powder is released by charging and cleaning, the equipment should be set up in an isolated place with use made of appropriate protective measures and clothing. In forging, stamping, pressing, and rolling, there are no finely dispersed aerosols. Consequently, the above-mentioned operations can be performed with ordinary hygienic precautions.

The requirements of safety engineering must also be met during hot pressing in a vacuum used for degassing beryllium in graphite molds with induction heating to 1100°C.

It is best to use a three-zone layout for work with beryllium [5]. The first zone is for the equipment (chambers, boxes, communications) and transfer of the raw material, intermediate (including beryllium), and finished products. The second zone is for the repair and cleaning of the equipment as well as for the loading, unloading, and transporting of beryllium. The third zone is where most of the workers stay to control the technological processes. In this kind of a layout, air is fed into the third zone and exhausted from the first zone.

The major task of safety engineers is to prevent beryllium dust from exceeding maximum permissible limits in the air. The set of measures used in a foreign plant [6] has been quite effective. They use airtight equipment with individual pumps to remove dusty air. Wet gases are cleaned by scrubbers made of wired polyester glass with a plastic lining. Dry gasses are successively cleaned in ordinary bag filters with a trapping rate of 99% and then in special bag filters (for ultrafine particles) containing 900 orlon bags within a lining of asbestos fabric 1148 m^2 in area, which provides for a load of 1.6 m^3/m^2 per minute. We should adopt this approach.

Laboratory experiments with beryllium compounds should be performed in exhaust hoods with air moving in the work openings at the rate of 1 m/sec at least. In laying out air lines, it is essential to provide a minimum number of elbows and other joints in which dust can settle. When work is in process, the accumulated dust should be removed at least once a month from the air lines and ventilation systems.

The air should be subjected to a two-stage cleaning operation before it is released into the atmosphere. Coarse-cleaning filters with crumb rubber or marble or glass fiber are used for the first stage, fine-fibered filters (e.g., made of FPP cloth) for the second stage. FP filtering material is available in the form of loosely woven linen (600 X 1600 mm in 0.1-0.5 mm thick layers) on a cloth base (made of coarse calico, capron [polycaprolactam resin and fiber], lavsan [tarilene], permil, glass fiber, paper). FPP-15 material - ultrathin polyvinyl chloride fibers with an average diameter of 1.5μ - is quite common. It is resistant to nitric, concentrated sulfuric, hydrochloric, and hydrofluoric acids.

When servicing equipment inside the enclosed compartments, it is necessary to wear a pneumatic suit with air supplied from a separate line or ventilators to provide at the place where the hose of the suit is connected a pressure of 500 mm of water column, with air fed in at the rate of 15 m^3/hour per suit. This pneumatic suit is an overalls with a tightly welded-on helmet made of polyvinyl chloride plastic 0.4-0.5 mm thick. In the face of the helmet is a sight glass 3 mm thick made of lucite. Inside and in the back of the helmet is an air line which ends outside and in the back of the suit in a sleeve to connect up the hose. The stream of air flows over the sight glass and then down through the space under the suit. It is removed through a valve from below.

All those who handle beryllium are furnished with a valveless dust respirator of the Lepestok (ShB-1) type, designed on the basis of studies by the Institute of Biological Physics, Academy of Medical Sciences, and the L. Ya. Karpov Institute of Physicochemistry. It traps 99.9% of the finely dispersed dust 0.1-0.2μ in diameter and weighs about 10 g. Its effective surface is 250 cm^2 with a total resistance of 3-3.5 mm of water column. The FPP-70-0.45 material offers resistance of no more than 1.9 mm with air moving at the rate of 30 liters/min. This respirator is a light half-mask consisting of 5 units of a round filter body (Korpus Fil'tra) between two layers of cheesecloth.

Special sanitary-hygienic precautions must be taken in maintaining the rooms. It is important, for example, to prevent the surfaces of the equipment, wires, walls, and floors from becoming contaminated. Cleaning is much easier if appropriate finishing materials are used for the various areas. Ceramic tile or plastic is recommended for the floors. The walls should be painted with an acid-resistant oil paint up to the ceiling. The rigid furniture should have a smooth surface painted with an oil or nitrocellulose enamel paint. There should be a general cleaning up at least once a month and all the surfaces washed with hot water; also a wet cleaning daily. The wastes should be removed in covered containers to places established for the purpose.

Bibliography

1. O. Ya. Mogilevskaya, "Dust from Beryllium-Containing Alloys," in the collection: Toksikologiya redkikh metallov (Toxicology of Rare Metals), Medgiz, Moscow, 1963.

2. C. Williams, "Significant Aspects of Exposure to Beryllium Compounds in Industry," Assup. Med., 1947.

3. H. MacMahon and H. Olken, Arch. Industr. Hyg., Vol 1, 1950.

4. C. Windecker, Electronics, No 41, 1961.

5. V. M. Kozlov and V. D. Turovskiy, Berilliy, Toksikologiya, klinika porazheniy, gigiyena truda (Beryllium -- Toxicology, Clinical Symptoms of Poisoning, Industrial Hygiene), Gosatomizdat, Moscow, 1962.

6. T. Meinhold, Chem. Process., No 17, 1962.

5214 59
CSO: 1897-D

-END-